

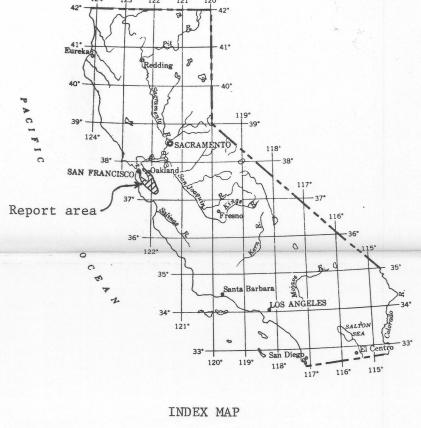
EXPLANATION

¹Boundaries dashed where data are lacking or are inadequate to categorize.

BOUNDARY OF MAXIMUM KNOWN EXTENT OF FLOWING WELLS UNDER NATURAL CONDITIONS

Boundary as of 1915 in San Mateo and Alameda Counties; as of earliest record prior to 1915 in Santa Clara County. Dashed where modified (Clark, 1924, pls. 11, 13, and 15)

UPPER EDGE OF VALLEY FLOOR AND BOUNDARY OF AREA INCLUDED IN THIS REPORT



SAN FRANCISCO CITY AND

CONTOUR INTERVAL 200 FEET DOTTED LINES REPRESENT 40-FOOT CONTOURS DATUM IS MEAN SEA LEVEL DEPTH CURVES AND SOUNDINGS IN FEET—DATUM IS MEAN LOWER LOW WATER

DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

MAP SHOWING AREAS BORDERING THE SOUTHERN PART OF SAN FRANCISCO BAY

WHERE A HIGH WATER TABLE MAY ADVERSELY AFFECT LAND USE

By D. A. WEBSTER

INTRODUCTION

This map presents general information about the depth to the top of the saturated zone (water table), outlines problems that may develop when the water table approaches land surface, and identifies areas where ground water in the northern part of Santa Clara Valley has potential to become troublesome to land owners, land users, and land managers. The information is intended to meet the needs of regional planners, but also may be of use to local government officials, industrial and engineering firms, construction companies, orchardists, residents, and other persons concerned with problems related to shallow ground water. The map shows generalized areas where the water table stands at depths of less than 5 feet, 5 to 10 feet, 10 to 20 feet, and more than 20 feet below land surface. Also shown is an area where water confined under pressure in deeper deposits may be troublesome if pumping from deep wells is decreased significantly.

The study was made in cooperation with the U.S. Department of Housing and Urban Development as a part of the San Francisco Bay Region Environment and Resources Planning Study. Data used in the preparation of the map were obtained from the files of the U.S. Geological Survey, U.S. Army Corps of Engineers, California Division of Highways, and several foundation-engineering firms that have offices in the San Francisco Bay area. Permission granted by the government agencies and engineering firms to use information contained in published and unpublished reports and in office files is gratefully acknowledged.

WATER-TABLE DEPTH

General. -- The water table may be defined as that surface in a nonartesian water body at which the pressure is atmospheric. It is determined by the levels at which water stands in wells that penetrate the water body just far enough to hold standing water. In wells which penetrate to greater depths, the water level will stand above or below the water table if an upward or downward component of ground-water flow exists (Lohman and others, 1972). The water table may be thought of as the upper limit of the zone of saturation. Below the water table the spaces between individual particles of earth material are filled with water, or as more commonly is said, the materials are saturated.

The depth to the water table varies both in location and in time. In general, the water table conforms to the configuration of the land surface although its relief is more subdued. The depth to the water table tends to be greater beneath hills and ridges than it is beneath valleys or other flat areas. In certain areas, where water accumulates above a local stratum of low permeability (a measure of the ease with which water flows through the subsurface), one or more perched water tables may exist above a more extensive regional water table. Visible, above-ground extensions of the water table are the surfaces of naturally occurring lakes, ponds,

Under natural conditions the shallowest water-table depths occur during the early spring months, following a period of winter recharge to the ground-water reservoir. Water-table depths commonly increase progressively during the late spring, summer, and autumn months as ground water is discharged into streams, evaporated from the land surface, and transpired by plants. An unusual decline of the water table may accompany a period of drought, and conversely, an unusual rise may follow a period of above-normal precipitation. These naturally occurring fluctuations can be intensified or reversed by man's activities. Such actions as the draining of swamps and pumping from wells tend to lower the water table, whereas the injection of water into wells and the impoundment of storm runoff with subsequent controlled releases into percolation facilities and permeable stream channels tend to raise the water table.

In Santa Clara Valley .-- The water-table depth in many parts of Santa Clara Valley cannot be defined precisely on the basis of available data. Throughout a substantial part of the area considered herein, a complex system of aquifers (consolidated rocks or unconsolidated deposits that contain sufficient saturated permeable material to yield significant quantities of water to wells and springs) underlies the land surface. This aquifer system, described by Clark (1924), California Water Resources Board (1955), California Department of Water Resources (1960, 1963, 1967, 1968), and others, consists of an upper nonartesian member overlying multiple artesian members that extend to depths of several hundred feet. Water in the artesian aquifers, however, is rarely under sufficient pressure to flow from wells. 1 By definition, water levels in artesian wells do not reflect the water table. In the northern part of the Santa Clara Valley artesian aquifers underlie land surface at such little depth that even many of the so-called shallow wells have been drilled into one or more of them. Water levels in such shallow wells commonly stand at a position between the water table and water levels in the deeper artesian wells. Thus, water levels in many wells in this area, whether shallow or deep, are not reliable indicators of water-table depth, and many water-level contour maps that have been published reflect a composite of water levels in wells that draw water from one or more artesian aquifers.

In an artesian aquifer the water pressure is greater than atmospheric. Hence, where wells puncture the aquifer, water rises in the hole above the point of puncture. However, contrary to popular concept, water need not flow from a well to be called artesian.

Water levels in shallow soil borings can be more useful as a guide to water-table depth because such borings commonly do not penetrate the substrata as deeply as do water wells. Consequently, water levels in borings that do not extend much deeper than the level at which water is first found are more likely to approximate the true position of the water

Base from U.S. Geological Survey

1970, sheet 3

San Francisco Bay Region 1:125,000,

PREPARED IN COOPERATION WITH THE

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

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The depth zones shown on the map are based on data obtained from more than a thousand soil borings made for foundation-engineering studies. The borings were made during all seasons and over a period of several years. Only a minor percentage of them met the ideal depth criterion; that is, penetration of the water body just far enough to hold standing water. However, it is believed that water levels recorded in the majority of the borings used in this study did approximate the water-table position. The depth zones shown on the map, therefore, are generalized, reflecting the general trend of data, and are not indicative of the water-table position of any one season, or point in time. Because of the many factors that may influence water levels, it can be expected that water-table depths slightly greater than, or slightly less than, those indicated may be found in many places.

Seemingly anomalous ground-water mounds are shown on the map for an area in Fremont and an area in southeast San Jose. These mounds probably are due to faults which impede the passage of water through the subsurface, thereby causing water to rise and appear at land surface as ponds in Fremont or as a swamp in southeast San Jose. The depth-to-water zones for both areas are based on rather meager data. The depression-like feature (D) shown for an area in Oakland is a reflection of a local rise of the land surface with an increasing depth to water.

Throughout a substantial part of the area shown on the map, the water table occurs below land surface at depths of 20 feet or less. It is within this area that problems associated with a shallow water table are of greatest concern. The problems are most applicable in areas denoted by the letter "A", where the depth to water generally is 5 feet or less below land surface. The problems decrease in number and severity toward areas denoted by the letter "D", where the depth to water usually is 20 feet or more below land surface.

PROBLEMS CAUSED BY SHALLOW GROUND WATER

Among the problems caused by a shallow water table are:

- 1. Flooding of basements and subbasements of buildings, highway underpasses, and other underground structures;
- 2. Complications in the installation of underground utilities, storage tanks, pipelines, and other structures that extend below the water table, and subsequent deterioration of such
- 3. Interference with the operation of septic tanks and other drainage structures designed to allow percolation of fluids; 4. Enhancement of conditions which promote subsurface fungal
- growths, rot of tree roots, and other plant diseases; 5. Differential settlement of buildings with inadequate foundations; 6. Building damage resulting from alternate swelling and shrinking
- of soils as the water table rises and declines; 7. Damage to buildings through the liquefaction of granular soils during earthquakes;
- 8. Contamination of potable ground water owing to the absence of the natural filter action provided by a thick unsaturated
- 9. Increased storm runoff, sediment transport, and erosion in areas where a shallow water table prevents the percolation of significant amounts of storm runoff into the ground.

Water contained in the artesian-aquifer system also can cause water-related problems if water levels in this system are allowed to approach the land surface. Decades ago water in the artesian aquifers was under sufficient pressure to flow from many wells drilled in a large area that is outlined on the map. Over the years, however, large withdrawals of ground water for agricultural, municipal, and industrial uses reduced artesian pressure, resulting in a lowering of water levels in the artesian system and a cessation of flow. At present (1973), water levels in the artesian system range from a few feet to as much as 300 feet below land surface. If the present rate of pumping were reduced significantly, the artesian pressure would increase rapidly, water levels would rise, and uncapped wells in some areas would flow again. If pumping were stopped, the effects probably would be expressed throughout the area where wells flowed years ago. Many long-abandoned wells, improperly-sealed wells, and wells no longer in operation would flow, which could cause waterlogging of soils in the vicinity of the discharging wells. Also, the increase in pressure would cause the water table to rise, resulting in the seepage of water into the basements of many buildings, perennial flow in many streams that are now intermittent, and marshy or swampy conditions in lowland areas near San Francisco Bay. In addition, many of the problems associated with a shallow water table would occur. Thus, from hydrologic considerations, it is desirable that wells located in the artesian area be pumped sufficiently to assure that water levels are maintained at a depth that will not cause wells to flow or otherwise adversely affect land use.

REFERENCES

California Department of Water Resources, 1960, Intrusion of salt water into ground water basins of southern Alameda County: Sacramento, Bull. 81, 74 p.

_1963, Alameda County investigation: Sacramento, Bull. 13, 196 p. 1964, Water well standards, Alameda County: Sacramento, Bull. 74-2,

_1967, Evaluation of ground water resources, South Bay, Appendix A, Geology: Sacramento, Bull. 118-1, 120 p.

__1968, Evaluation of ground water resources, South Bay, Volume 1,

Fremont study area: Sacramento, Bull. 118-1, 117 p. California Water Resources Board, 1955, Santa Clara Valley investigation: Sacramento, Bull. 7, 154 p.

Clark, W. O., 1924, Ground water in Santa Clara Valley, California: U.S. Geol. Survey Water-Supply Paper 519, 209 p. Lohman and others, 1972, Definitions of selected ground-water terms--revisions and conceptual refinements: U.S. Geol. Survey Water-Supply Paper 1988, 21 p.

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